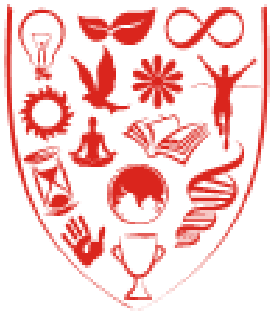
COMPARATIVE STUDY AND ANALYSIS OF BIT ERROR RATE of CDMA, OFDM & UWB FOR DIFFERENT MODULATION TECHNIQUES

Research Protocol
For Registration for Ph.D Programme
Submitted by
Arun Kumar



Under the Guidance of
Dr. Manisha Gupta
Associate Professor
Department of Physics,
JECRC University, Jaipur

2014
JECRC UNIVERSITY, JAIPUR

CONTENTS

S.No.	Topics	Page Nos.
1.	Introduction	1-3
2.	Part Literature Review	3
3.	Statement of Research Problem	9
4.	Objective of the Study	10
5.	Scope of the Study	10
6.	Significance of the study	10
7.	Limitation	11
8.	Methodology	11-13
9.	Month Wise Plan Of Work	14
10.	Month Wise Plan Of Work (Graphical Representation)	15
11.	References	16-19

INTRODUCTION:

The world's first wireless telephone conversation occurred in 1880, when Alexander Graham Bell and Charles Sumner Tainter invented and patented the photo phone, a telephone that conducted audio conversations wirelessly over modulated light beams. Guglielmo Marconi and Karl Ferdinand Braun were awarded the 1909 Nobel Prize for Physics for their contribution to wireless telegraphy. Wireless communication is the transfer of information between two or more points that are not connected by an electrical conductor. The most common wireless technologies use radio. With radio waves distances can be short, such as a few meters for television or as far as thousands or even millions of kilometres for deep-space radio communications [1]. Code Division Multiple Access (CDMA), Orthogonal Frequency Division Multiplexing (OFDM) and Ultra Wide Band (UWB) are the well known air interface technologies in modern mobile communication.With the increasing demand in wireless communication, it has become necessary to give better service to users by using better technique. This work proposes and analyzes the bit error rate of CDMA, OFDM and UWB for different modulation schemes such as Binary Phase shift Keying (BPSK), Quadrature Phase Shift Keying (QPSK) and Quadrature Amplitude Modulation (QAM). By Choosing a reliable modulation scheme and better filtration Technique the enhancement of the performance can be obtained in transmitter and receiver of CDMA, OFDM and UWB system [2]. Simulated result is shown to analyze and compare the performance of these systems by using additive white Gaussian noise channel (AWGN) [3]. The technologies like CDMA, OFDM, and UWB has increased the standards for wireless communication system in terms of high data speed, mobility both for short range and long range communication. With the increasing uptake of so-called smart phones in recent times, it has been repeatedly identified that state-of-the-art cellular networks are fast being rendered incapable of consistently delivering the excessively high throughputs demanded by the Internet-savvy users of such devices [4]. If we're all to use our mobile devices to work and play anywhere, we want access to streaming services and all our own "stuff", instantly, on devices as small as a Smartphone or as large as the screen in an auditorium – properly formatted in the size of the screen, of course. We're already socially networked, 24 hours per day, 7 days a week [5].

In a CDMA communication system, a unique binary spreading sequence (a code) is assigned for each call to every user. The user's signal is multiplied by the assigned code and "spread" onto a bandwidth much wider. All the active users share the same frequency spectrum at the same time. The signal of each user is separated or "de-spread" from the others at the receiver using a correlator key with the associated code sequence [6]. Spread spectrum techniques use a transmission bandwidth that is several orders of magnitude greater than the minimum required signal bandwidth. These systems were designed using spread spectrum because of its security and resistance to jamming.

Ultra wide band (UWB) radio is based on the radiation of waveforms formed by a sequence of very short pulses; very short refers to pulse duration which in communication applications is typically of about a few hundreds of picoseconds. The information to be transferred is usually represented in digital form by a binary sequence, and each bit is transferred using one or more pulses.UWB is the leading technology for freeing people from wires, enabling wireless connection of multiple devices for transmission of video, audio and other high-bandwidth data. UWB, short-range radio technology, complements other longer range radio technologies such as Wi-Fi*, Wi-MAX, and cellular wide area communications [7].

OFDM (Orthogonal Frequency Division Multiplexing) is one of the most promising technologies for Fourth Generation high-speed mobile communications. However, it has a high PAPR (Peak-to Average Power Ratio) and requires wide dynamic range of transmission linearity [8].

There is a fundamental trade-off in communication systems. Simple hardware can be used in transmitters and receivers to communicate information. However, this uses a lot of spectrum which limits the number of users. Alternatively, more complex transmitters and receivers can be used to transmit the same information over less bandwidth. To transit to more and more spectrally efficient transmission techniques requires more and more complex hardware. Complex hardware is difficult to design, test, and build. This trade-off exists whether communication is over air or wire, analog or digital. Modulation provides more information capacity, compatibility with digital data services, higher data security, better quality communications, and quicker system availability [9].

Till today modulation is only defined as: “process of sending the message with the help of carrier” but now the efficiency, data-rate of communication depend upon on the choice of modulation scheme. So it is essential that we should know the advantage and disadvantage of different modulation scheme in wireless communication system so that one can adopt the efficient one to improve the communication system. Although much of the work is not done focusing on the modulation scheme so here we proposed a work that will analyse the Transmitter and Receiver of CDMA, OFDM and UWB by using different modulation techniques by defining BER, Scatter plot of Transmit Signals and Received Signal.

2. PART LITERATURE REVIEW:

Describes the need that demand continued development of communication systems and explain some background of OFDM, CDMA and UWB. CDMA technique is based on the spread spectrum communication. The CDMA with existing modulation Technique have disadvantages that the presence of a strong interferer can raise the noise significantly for other channels which can cause communication to be halt under serious condition and also it need a huge amount of power which result in implementation of extra hardware to adjust the power requirement. For a spread spectrum signal the transmission bandwidth is much wider than the bandwidth of the original signal [10]. A work done by Ghanim *et.al* shows that QAM gives less bit error rate that makes CDMA more flexible and suitable for mobile communication next generation technology [11]. Recently simulation performed by Arun *et.al* shows that in a CDMA transmitter, the information is modulated by a spreading code, and in the receiver it is correlated with a replica of the same code. Thus, low cross-correlation between the desired and interfering users is important to suppress the multiple access interference. Good auto-correlation properties are required for reliable synchronization and reliable separation of the multipath components. Having good auto-correlation properties is also an indication of good randomness of a sequence, which allows us to connect other important sequences properly and QPSK is better modulation scheme for CDMA [12]. CDMA Access is a new technology used in wireless communication devices. CDMA gives us secure and reliable based calls [13]. A review done by Bhardwaj *et.al* shows over the years researchers have sought

ways to extend the user capacity of CDMA systems either by employing optimum [maximum likelihood (ML)] detection, interference cancellation (IC) methods, or other methods such as the de-correlating receiver [14]. CDMA is analogous to the last example where people speaking the same language can understand each other, but not other people. Similarly, in radio CDMA, each group of users is given a shared code. Many codes occupy the same channel, but only users associated with a particular code can communicate [15]. CDMA is the platform on which 2G and 3G advanced services are built. It is the fastest growing wireless technology and it will continue to grow at a faster pace than any other technology [16]**.** CDMA can effectively reject narrow band interference. Since narrow band interference affects only a small portion of the spread spectrum signal, it can easily be removed through notch filtering without much loss of information. CDMA devices use a rake receiver, which exploits multipath delay components to improve the performance of the system In a CDMA system; the same frequency can be used in every cell, because channelization is done using the pseudo-random codes. Reusing the same frequency in every cell eliminates the need for frequency planning in a CDMA system; CDMA systems use the soft hand off, which is undetectable and provides a more reliable and higher quality signal[17].

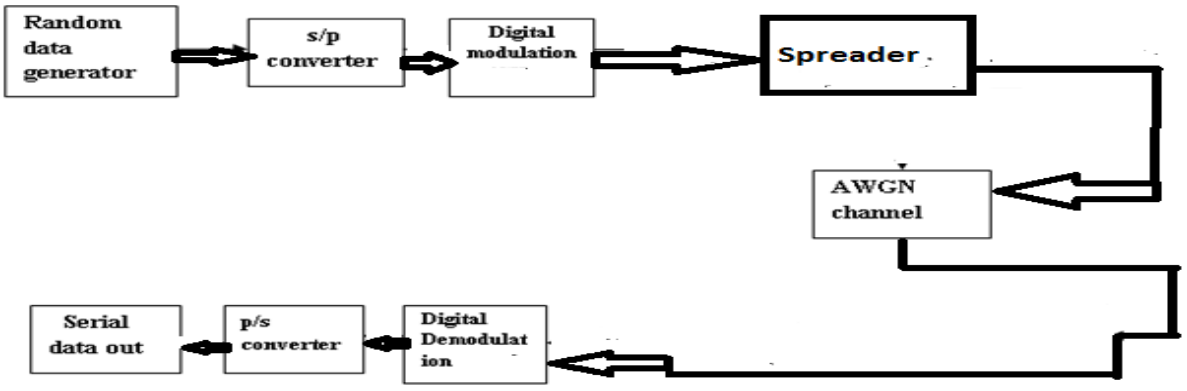


FIG1. BLOCK DIAGRAM OF CDMA

In ultra-wideband (UWB) system design, there are always tradeoffs between maximum transmit distance, data rate, transmit power, and system complexity. Different data modulation schemes such as pulse-position modulation (PPM), pulse-amplitude modulation (PAM), phase-shift keying (PSK), or on-off keying (OOK) have been used in UWB communications with relative success depending on the targeted

application as work done by Naanaa *et.al* [18]. According to Hidayat *et.al* the performance of UWB can significantly vary according to which system parameters are considered such as narrowband interference (NBI) robustness, symbol error rate (SER), system complexity, data rate, or maximum transmit power with respect to transceiver distance and channel capacity. For instance, if minimum complexity is important, then OOK modulation would be the best choice. However, it is very sensitive to noise [19]. On the other side, Zaman *et.al* study shows, if interference robustness and power efficiency are the parameters to consider, binary PSK (BPSK) and M-ary PPM (M-PPM) can be the best candidates. Nevertheless, M-PPM deals with multidimensional signals, whereas M-PAM has only one dimension [20]. Ultra-wideband communications is fundamentally different from all other communication techniques because it employs extremely narrow RF pulses to communicate between transmitters and receivers. Utilizing short-duration pulses as the building blocks for communications directly generates a very wide bandwidth and offers several advantages, such as large throughput, covertness, robustness to jamming, and coexistence with current radio services [21]. Developed in the early 1960s, time-domain electromagnetic, the study of electromagnetic-wave propagation from a time-domain perspective, has given birth to a fascinating new technology, which today is commonly referred to as ultra-wideband (UWB). It has now been slightly more than 25 years since the 1978 seminal paper of Bennett and Ross, which summarized UWB's early applications [22]. Ultra-Wideband (UWB) technology, based on the Wi-Media standard, brings the convenience and mobility of wireless communications to high-speed interconnects in devices throughout the digital home and office. Ultra-wideband (UWB) communication systems have an unprecedented opportunity to impact communication systems [23]. The terms associated with UWB include impulse, short-pulse, no sinusoidal, carrier-less, time domain, super wideband, fast frequency chirp and monopulse. The growing demand for wireless data capability in portable devices at higher bandwidth but lower in cost and power consumption than currently available [24.]

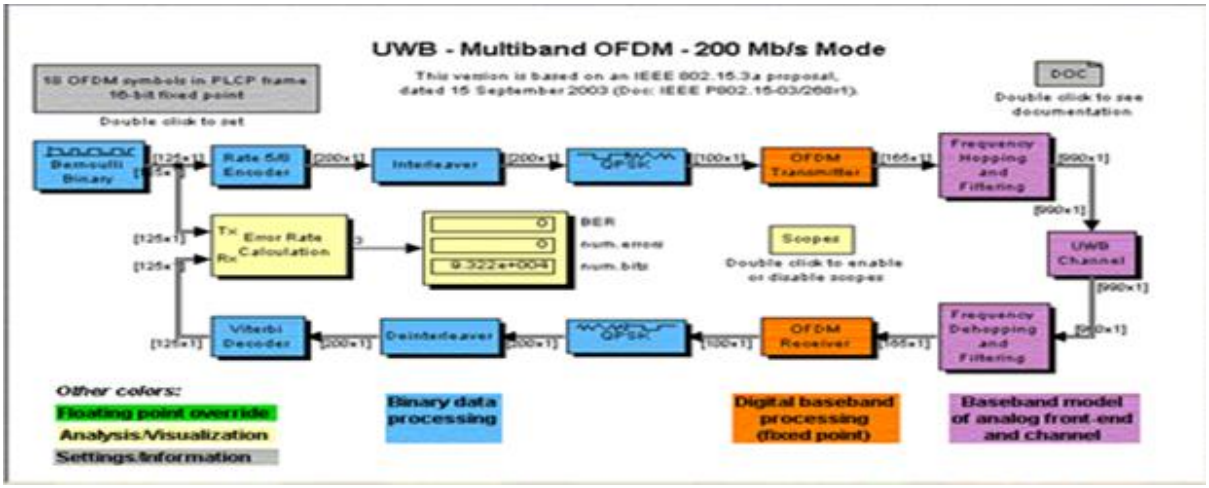


FIG2. Block Diagram OF UWB.

Shrinking semiconductor cost and power consumption for signal processing[25]**.** Pulse Amplitude Modulation (PAM), Pulse Position Modulation (PPM) used in UWB has certain disadvantage : Spectrum of PPM is difficult to analyze due to the non linear nature of PPM Modulator ,synchronisation in nano second pulse between transmitter and receiver is difficult and the pulse of PPM and PAM undergo a severe distortion ,thus channel estimation is very complicated The basic idea of OFDM is using a large number of parallel narrow-band sub-carriers instead of a single wide-band carrier to transport information [26]**.** OFDM is a Multicarrier Transmission technique which divides the available spectrum into many carriers each one being modulated by a low data rate stream as study done by Li et.al [27]. OFDM is similar to Frequency Division Multiple Access (FDMA) in that the multiple user access is achieved by sub-dividing the available bandwidth into multiple channels, which are then allocated to users. This is achieved by making all the carriers orthogonal to one another, preventing interference between them [28]. OFDM will play an important role in realizing Cognitive Radio (CR) concept by providing a proven, scalable, adaptive technology for wireless communications**.** Inter-symbol interference (ISI) is reduced completely by using a guard band in every OFDM symbol. In OFDM, using guard band is cyclically extended in order to avoid inter-carrier interference (ICI). The advantage of OFDM system is robustness to channel fading in wireless communication environment. Frequency selective fading is reduced by increasing the number of subcarriers [29]. By choosing the coherence bandwidth is greater than the subcarrier spacing of the channel, each subcarrier is going to be affected by a

flat channel and thus no or simple channel equalizer is needed. OFDM is used in many wireless applications today. Already it is used in different WLAN standards (e.g. HIPERLAN-2, IEEE 802.11a), Wireless Metropolitan Area Networks (WMAN), Digital Video Broadcasting (DVB), 3GPP-LTE, Asymmetric Digital Subscriber Line (ADSL) and power line communications. Despite of OFDM advantages, it has a major potential drawback in the form of high Peak-to-Average Power Ratio (PAPR). The high PAPR has nonlinear nature in the transmitter and it degrades the power efficiency of the system as per Paiement *et.al* [30].

Multi Carrier modulation (MCM) i.e. OFDM system has recently gained relevance among modulation schemes because of its intrinsic robustness to frequency selective fading channels. This is one of the reasons that made MCM a candidate for systems such as Digital Audio and Video Broadcasting (DAB and DVB-T), Digital Subscriber Lines (x-DSL), and Wireless LAN [31]. One of the major drawbacks of any MCM system, which is often an obstacle to its use, is the fact that the signal has a non-constant envelope, i.e. it exhibits peaks whose power strongly exceeds the mean power: the signal is said to have a high PAPR. This prevents use of high-efficiency amplification devices (High Power Amplifiers, HPA), which exhibit deep non-linearity that give rise to inter modulation products; the latter causes in-band distortion and increases Out-Of-Band Radiation (OOBR), which results in a disturbing Adjacent Channel Interference (ACI) and a Bit-Error-Rate (BER) increase. To overcome such effects, a reduction of the working point of the amplifier is traditionally used, with a consequent reduction of the HPA efficiency. This leads to a growth of power consumption and costs. Objective of this research is the analysis of techniques for processing the signal at the transmitter side of a multi-carrier system, which are capable to reduce the PAPR of the original multi-carrier signal. Some PAPR reduction techniques are introduced. These techniques include: amplitude clipping, windowing, coding, tone injection (TI), tone reservation (TR), active constellation extension (ACE), selective scrambling and selected mapping (SLM). But these techniques have some drawbacks: increase the transmit power and BER as well as computational complexity [32] .A Basic OFDM system model is described below. Here an input data symbols are supplied into a channel encoder that data are mapped onto BPSK/QPSK/QAM constellation. The data symbols are converted from serial to parallel and using Inverse Fast Fourier Transform (IFFT) to achieve the time domain OFDM symbols [33]. Time domain symbols can be represented as:

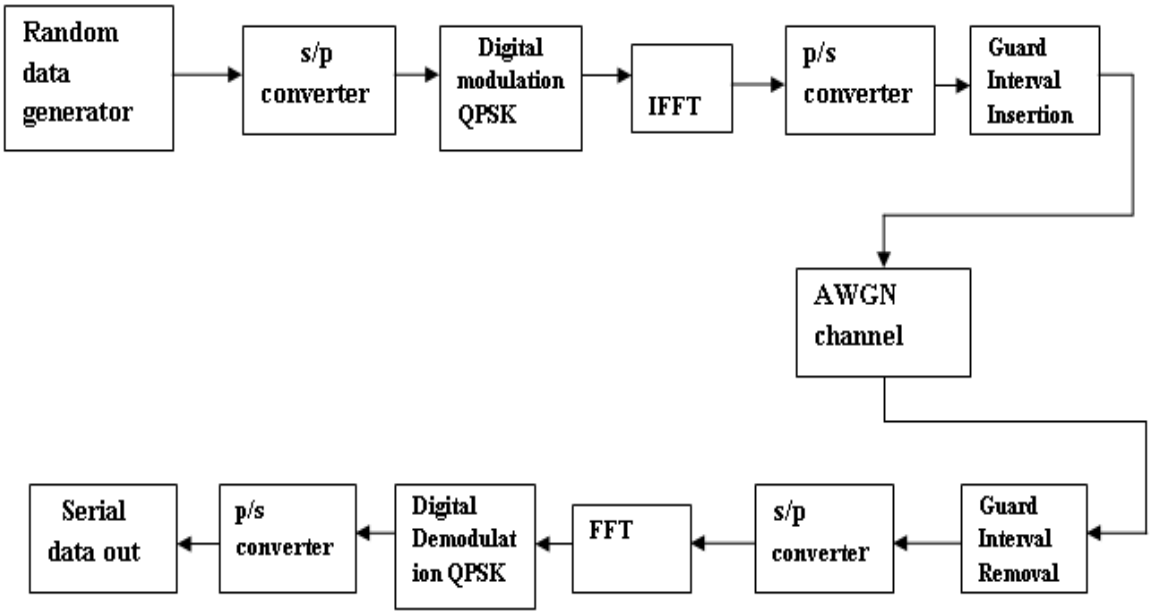


Fig3. Block Diagram of OFDM systems

OFDM is a good candidate for CR because of its flexibility and adaptability .The orthogonality preservation procedure in OFDM are much simpler compared to CDMA/TDMA technique in multipath conditions.

The design of any digital communication system begins with a description of the channel (received power, available bandwidth, noise statistics and other impairments, such as fading), and a definition of the system requirements (data rate and error performance). Given the channel description, we need to determine design choices that best match the channel and meet the performance requirements. An orderly set of transformations and computations has evolved to aid in characterizing a system's performance [34]. The choice of digital modulation scheme will significantly affect the characteristics, performance and resulting physical realisation of a communication system. There is no universal 'best' choice of scheme, but depending on the physical characteristics of the channel, required levels of performance and target hardware trade-offs, some will prove a better fit than others. Consideration must be given to the required data rate, acceptable level of latency, available bandwidth, anticipated link budget and target hardware cost, size and current consumption. The physical characteristics of the channel be it hardwired without the associated problems of fading, or a mobile communications system to a F1 racing

car with fast changing multipath, will typically significantly affect the choice of optimum system [35].

3. STATEMENT OF THE RESEARCH PROBLEM:

"COMPARATIVE STUDY AND ANALYSIS of BER of CDMA, OFDM & UWB for DIFFERENT MODULATION TECHNIQUE**".**

1. Bit Error Rate (BER): It may be defined as total error in the received signal to the ratio of total transmitted signal.
2. Code Division Multiple Access (CDMA): is a promising technique for radio access in cellular mobile and personal Communication System. CDMA in cellular system offers attractive features such as potential for high spectrum efficiency, soft capacity, and soft handover.
3. Orthogonal Frequency Division Multiplexing (OFDM): OFDM is similar to Frequency Division Multiple Access (FDMA) in that the multiple user access is achieved by sub-dividing the available bandwidth into multiple channels, which are then allocated to users.
4. Ultra Wide Band (UWB): Traditional narrowband communication systems modulate continuous waveform (CW) RF signals with a specific carrier frequency to transmit and receive information.

1. OBJECTIVE OF THE STUDY:

- To Simulate, Design and Verify the concept of conventional and next generation transmitter and receiver of CDMA, OFDM and UWB for different modulation schemes.
- To analyze and compare CDMA, OFDM and UWB by determining the BER for each modulation scheme.
- To determine a new modulation scheme suitable for next generation wireless communication system.

2. SCOPE OF THE STUDY:

A lot of companies and universities like Samsung, TCs, Wireless@MIT, METIS – Mobile and Wireless Communications Information Society, Technical University of Dresden, Germany, Centre for Communication Systems Research (CCSR), University of Surrey, UK is investing lot of money in Telecommunication system.

As a Researcher, I believe with this study the basic wireless communication system can be analysed and can be improved to achieve the motto of Communication System. One can analyze the role of different modulation techniques for improving the BER, interference, data rate, ISI in Wireless Communication System. Moreover, by understanding the above concept, a huge contribution can be done in development of Fifth Generation Mobile Communication.

3. SIGNIFICANCE OF THE STUDY:

1. It can give detailed understanding of the Techniques used in Transmitter and Receiver of Wireless Communication System.
2. Moreover, it will give a direction to all the researchers of communication system try to implement the network which can be free from all hurdles of existing Wireless Communication System like fading, low-data rate, etc.
3. One can also analyze the role of Transmitter and Receiver for the better utilization of bandwidth, efficiency, throughput, etc.
4. Contribution towards the vision of 2020.

4. LIMITATION:

There is no limit in the scope of the study but the full work will be realized through the simulation because it will be very costly for hardware implementation of above Techniques.

5. METHODOLOGY:

The work will start with the Design of Transmitters and Receivers of CDMA, OFDM and UWB.

1. The work deals with the design and implementation of conventional and next generation CDMA, OFDM and UWB transmitter and receiver . Different modulation techniques are used to analyse the system.
2. Study the performance of the system by BER vs SNR, Transmitted signal, Received Signal, Input and output constellation.
3. The performance of the system has been studied by using a Mat-lab 2014. ODE- 45 equation solver is being used to solve the first order differential equations.

6. Month Wise Plan of Work (Graphical Representation):

S.No.	Activities	Months
1.	Literature Review.	1-22
2.	Design of CDMA Transmitter and Receiver for Different Modulation Scheme.	3-7
3.	Design of OFDM Transmitter and Receiver for Different Modulation Scheme.	8-12
4	Design of UWB Transmitter and Receiver for Different Modulation Scheme,	13-17
5.	Comparative Study and Analysis of Above Techniques	18-22
6.	Thesis Preparation	23-24

7. MONTH WISE PLAN OF WORK:

S.No	Course Research	1 year Month wise												II Year Month wise										
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
1.	**Literature Review**																								
2.	**Design of CDMA Tx and Rx for Different modulation scheme and Pub1.**																								
3.	**Design of ofdm Tx and Rx for Different modulation schemeand pub2.**																								
4	**Design of UWB Tx and Rx for Different modulation scheme and pub3.**																								
5.	**Comparative Study and Analysis of above Techniques and pub4.**																								
6.	**Thesis Preparation and submission.**																								

8. Reference:

1. Google http:// Wikipedia, the free encyclopedia.
2. Singh M., Schdeva S., Arora A., Singh U., “Analysis of CDMA by Using Simulink “, *International Journal of Electronics and Computer Science Engineering”* **1(3),** 384-392,(2011).
3. Yun M., Rong Y., Zhou Y., Choi H., Kim J., Sohn J., Coi J., “Analysis of Uplink Traffic Characteristics and Impact on Performance in Mobile Data Networks*,” IEEE International Conference on Communications (ICC)*, (Beijing, China), 3-13,(2008).
4. Measuring the Information Society: The ICT Development Index. International TelecommunicationUnion,UK,*www.itu.int/ITUD/ict/publications/idi/material/2009/MIS2009_w5.pd.*
5. Patil S., Patil V., Bha P., “A Review on 5G Technology”, *International Journal of Engineering and Innovative Technology*, 1**(1),** 26-30,(2012)..
6. Benedetto M., Vojcic B., “Ultra Wide Band Wireless Communications: A Tutorial” *Journal of Communications and Networks*, **5(4**), 290-302, (2003).
7. Ullah M., Priantoro A., Uddin M., "Design and Construction of Direct Sequence Spread Spectrum CDMA Transmitter and Receiver" *Proceedings of 11th International Conference on Computer and Information Technology***,** Turkey, 114-119, (2008).
8. Ojima M., Hattori T., “PAPR Reduction Method Using Clipping and Peak-windowing in CI/OFDM System” *Vehicular Technology Conference* **,**USA,1356-1361 , (2007).
9. Feher, “Applications of Digital Wireless Technologies to Global Wireless Communications “, *International Journal of advance Research in Computer Engineering & Technologyij*,**2(4),**1389-1392,(1997)

10. Murako R., Covarrublas D., Arvizu A., Mendieta J., " Design and Implementation of CDMA Transmitter for Mobile Cellular communication" *Journal of Applied Research and Technology*, **1(002),**127-136, (2003).
11. Ghanim M., Abdullah M.,**"** Analysis of MC-CDMA System in Mobile Communications", *I.J. Information Technology and Computer Science,* **12(2),**87-94,(2012).
12. Kumar A., Naznin R., "Simulation of Different Modulation Technique in CDMA System using AWGN channel". *International Journal Of Computer & Technology*,**1(3),**2346-2354,2277-3061,(2013).
13. Verdu S., "Minimum Probability of Error for Asynchronous Gaussian Multiple-access channels," *IEEE Trans. Inform. Theory*, **vol. IT-32**, 85–96, 0018/9448/86/0108. (1986).
14. Bhardwaj M., "*A Review on OFDM: Concept, Scope & its Applications" - IOSR Journal* , **1(1)** , 07-11, 2278-1684, (2012).
15. Awasthi A., Singh D., Srivastava V., "Simulation of QPSK Modulation Technique in CDMA System Using Rician Channel". *Conference on Advances in Communication and Control Systems*, Atlantic Press, 459, (2013).
16. Kumar A., suman, Renu, "Comparision of 3G Wireless Networks and 4GWireless Networks*", International Journal of Electronics and Communication Engineering*, **6(1),** 1-8, 0974-2166 , (2013).
17. Google, "www.wirelessblog spot. in./HTML".
18. A Naanaa., Belghith S., "Performance enhancement of a time hopping—pulse position modulation ultra-wideband system using guided local search*," IET Journal of Communications,* **5(15),** 192-196,(2011).
19. Hidayat R. ,Miyanaga Y., "IR-UWB Pulse Position Modulation and Pulse shape Modulation through S-V Channel Model*," in Proceedings of the 2nd International Conference on Communication Software and Networks, US,* 214–217, (2010).

20. Zaman A., Islam N., “Modulation schemes and pulse shaping in ultra wideband,” *in Proceedings of the IEEE Southeast conference*, 142–146, US (2008).
21. Withington.P, “Ultra-wideband RF: A Tutorial,” Doc. IEEE 802.15-00/083r0,http://grouper.ieee.org/groups/802/15/pub/2000/Mar00/00083r0P802-15_WG-UWB-Tutorial.
22. Fontana, R J., “Recent System Applications of Short-pulse Ultra-Wideband (UWB) technology”, *IEEE Transactions on Microwave Theory and Techniques, 52***(9)**, 2087 – 2104, (2004).
23. Viittala H., Hämäläinen M., Iinatti J.,” “COMPARATIVE PERFORMANCE STUDIES OF INTERFERED LOW DATA RATE ULTRA WIDEBAND SYSTEMS IN MULTIPATH CHANNEL” *The 18th Annual IEEE International Symposium on Personal, Indoor and Mobile Radio Communications*, Athens, 1-5, (2007).
24. Federal Communications Commission (FCC), “Revision of Part 15 of the commission’s rules regarding ultra-wideband transmission systems,” First Report and Order, ET Docket 98-153, Federal Communication Commission 02-8, Washington, DC, USA, adopted on 14 February 2002, and released on 22 April 2002.
25. Foersterp J., Green E., Somayazulu S., Leeper D.,” Ultra-Wideband Technology for Short- or Medium-Range Wireless Communications*”, Intel Technology Journal Q2, 1-11*,(2001)
26. Tureli U., Kivanc D., Liu H , “Experimental and Analytical Studies on a High-Resolution OFDM Carrier Frequency Offset Estimator*”, IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY*, **50(2),** 629-643, (2001).
27. Li., Geofferey Y., Stuber., L G.,” Orthogonal Division Multiplexing For Wireless Communication”, Springer Publication,UK, Third Edition, 78(2009).
28. Baranwal R., Kumar A., Jaiswal A.,”Performance Evaluation of Different Phase Rotation on OFDM Signal”, International *Journal of Scientific and Research Publications*, 2**(5),** 1-4, (2012).

29. R V., “Evaluation of Single Carrier and Multicarrier Modulation Techniques for Digital ATV Terrestrial Broadcasting CRC Rep”, Canada, CRC-RP-004, 2004.
30. Paiement., R V., Ottawa, “An Enhancement of Peak to Average Power Ratio Reduction in OFDM Using CAP-PT Method”, *International Journal of Modern Engineering Research,* **2(5),** 3699-3704, (2012).
31. Han S., Lee J., "An overview of Peak - to - Average Power Ratio Reduction Techniques for Multicarrier Transmission,"*Magazine of IEEE Wireless Communications*, **12(2),** 56-65, (2005).
32. Zolghadrasli., Ghamat M., “An Overview of PAPR Reduction Techniques for Multicarrier Transmission and Propose of New Techniques for PAPR Reduction “*IRANIAN JOURNAL OF ELECTRICAL AND COMPUTER ENGINEERING*, **7(2),** 115-120 ,(2008).
33. Van Nee R., and Prasad R., “OFDM for Wireless Multimedia Communications”, Artech House Publishers, Massachusetts, First Edition, 56, *(2000).*
34. Bullock S.,”Transceiver and System Design for Digital Communication”, SCI Tech Publishing, US, Third Edition, 217, (2009).
35. Anderson J., Svensson A.,” Codded Modulation System” Springer Publication, UK, Fourth Edition, 35-37, (2003).